

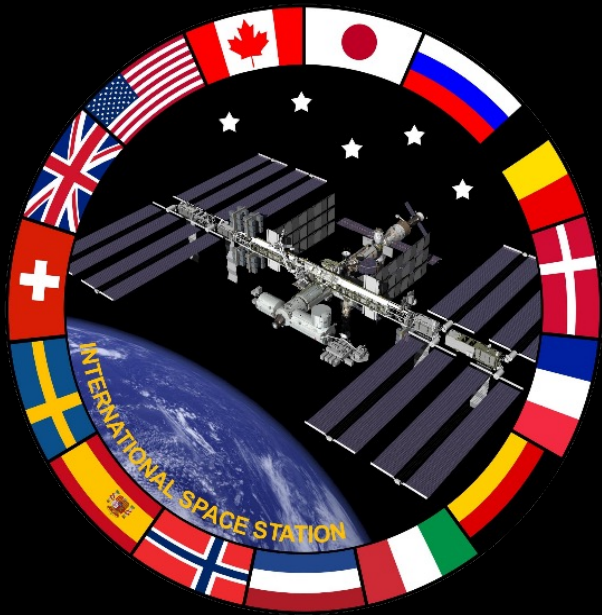


International Space Station Status

Robyn Gatens

International Space Station Director
Space Operations Missions Directorate
November 2023

Agenda



ISS Increment Overview

ISS Operational Status

Utilization Highlights

LEO Transition

ISS Mission Goals – The Decade of Results

Enable Deep Space Exploration

Validate Exploration Technologies and Reduce Human Health Risks

26 NASA tech demos initiated since 2018
~20 human health risks continuing to be characterized and countermeasures developed

Over 500 payloads have flown through the ISS National Lab; 75% from the commercial sector
\$1.8 billion of capital raised by startups post-flight
20 In-Space Production Applications Awards to date
2 Private Astronaut Missions

Foster Commercial Space Industry

In partnership with Commercial LEO Office
Incubate in-space manufacturing, support commercial LEO facilities and customers

Conduct Research to Benefit Humanity

Life-saving medical research & applications, understanding climate change, sharing discoveries with all

> 3700 investigations
> 5300 investigators represented
> 3100 scientific results publications
~3.5 million images of Earth captured

Involves 100,000+ people at 500 contractor facilities in 37 U.S. states and 16 countries
>10 million student activities in 2023
18 million people follow social media accounts

Inspire Humankind

Broaden reach of space benefits, engage public, create diverse future STEM workforce

Enable International Collaboration

Maintain & expand international partnerships, set norms & standards

~more than 2000 international-led investigations through Expedition 69
117 countries/areas with ISS research and education participation
1st ISS increment UAE astronaut

>23 years continuous presence in space
>260 cargo and crew missions to ISS

Provide a Continuous LEO Infrastructure and Destination

Ensure continuous human presence in LEO - no gap; provide destination for crew & cargo transportation

ISS Increment Overview

Increment 70 Overview



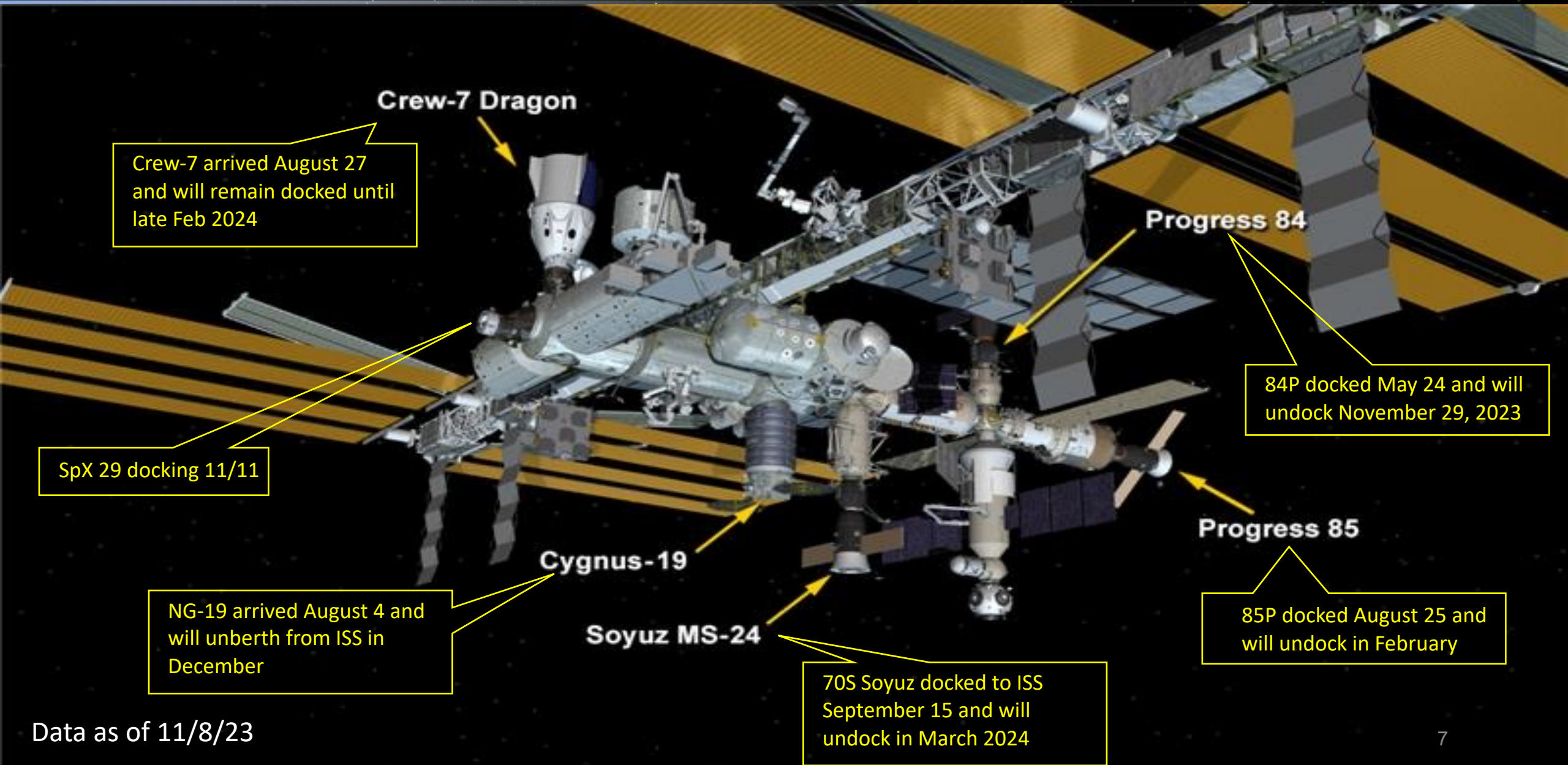
- Soyuz 70S Launch/Dock
- SpaceX-Crew8 Launch/Dock
- SpaceX-Crew7 Undock/Splashdown
- SpaceX CRS-29 Launch/Dock
- Soyuz 69S Undock
- RS EVA 61
- US EVAs 89 & 90
- Axiom-3 Private Astronaut Mission (PAM)
- Progress 86P Launch/Dock
- Progress 84P Undock
- Northrop Grumman CRS-19 Undock
- Northrop Grumman CRS-20 launch/berth
- SpaceX CRS-30 Launch/Dock
- Progress 85P undock
- Soyuz 71S Launch/Dock
- Soyuz 70S Undock



Flight Engineers Nikolai Chub (Roscosmos) Konstantin Borisov (Roscosmos), Commander Andy Mogensen (ESA), Flight Engineers Oleg Kononenko (Roscosmos), Jasmine Moghbeli (NASA), Satoshi Furukawa (JAXA) Loral O'Hara (NASA) .

ISS Operational Status

Current Configuration



Crew-7 Dragon

Crew-7 arrived August 27 and will remain docked until late Feb 2024

Progress 84

84P docked May 24 and will undock November 29, 2023

SpX 29 docking 11/11

Progress 85

85P docked August 25 and will undock in February

Cygnus-19

NG-19 arrived August 4 and will unberth from ISS in December

Soyuz MS-24

70S Soyuz docked to ISS September 15 and will undock in March 2024

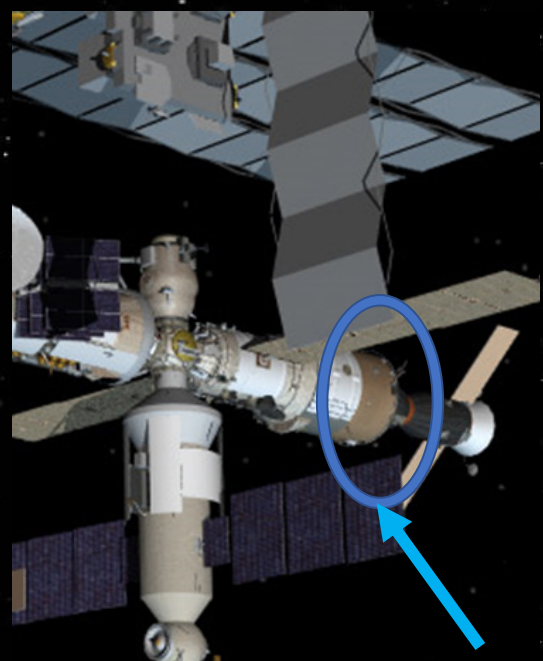
Data as of 11/8/23

Recent/Upcoming Spacewalks (EVAs)



- **RS EVAs – June through October 2023**
 - RS EVA #59 – Equipment R&R / SM Inspection
 - RS EVA #60 – Portable workstation transfer from MRM-1 to MLM by the ERA. MMOD shielding.
 - RS EVA #61 – MLM Radiator isolation, payload deploy
- **U.S. EVAs – iROSA Install 1A and 1B (complete)**
 - Two separate EVAs that installed iROSA's on 1A and 1B arrays.
 - 6 iROSAs now deployed on ISS (last 2 planned in 2025)
- **U.S. EVA 89 – completed Nov 1**
 - SARJ lubrication, BGA survey, RFG removal deferred due to time constraints
- **U.S. EVA 90 – RFG Retrieval– February 2023**
 - RFG retrieval
 - Swap sample collection of different surfaces with canisters which will be returned to ground for analysis

ISS Significant Items of Interest



ISS Atmosphere Leak Location
(Aft end of Service Module)

- **Atmosphere Leak**

- Identified atmosphere leakage increase in September 2019. The leak presents no immediate danger to the crew, or vehicle, at its current state. Multiple measures in work to identify the source(s) of the leak from the PrK section of the Russian Service Module (SM).
- Kapton tape applied to the PrK pressure shell and decrease in leak rate was observed. Three repairs have been completed with no issues. Strain gauge data is being collected for events of interest. Thus far, all strains measured to date are low and in-family with predictions.
- That section of the SM is being isolated appropriately to minimize consumables loss.
- Current leak ~1.0 lbm/day
- PrK hatch closed when access not required
- Roscosmos team / crew continue to search for leaks and provide samples/data to the ground team for inspection.
- New devices were flown on NG-19 for diagnostic use

- **End-of-life Deorbit Planning**

- RFP released September 19 to develop US Deorbit Vehicle, contract award targeted spring 2024

- **Russian Coolant Leaks**

- NASA and Roscosmos continue to evaluate thermal leaks on visiting Vehicles
- Leak in MLM backup radiator identified in October. Currently, no impact to operations

Utilization Summary

Exploration Capabilities Development Technology Demonstrations: FY23 Hardware



Life Support

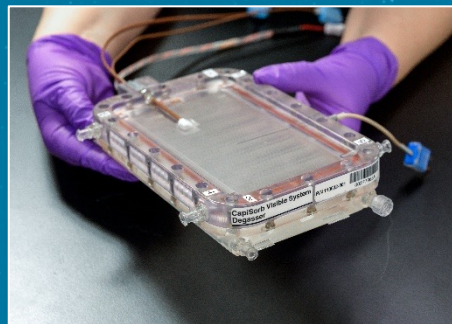
- CapiSorb Visible System: Investigation Complete
- Upgraded Water Processor Assembly (WPA) Catalytic Reactor Re-fly: Delivered, install in work (Fall 2023)
- Urine Processor Assy (UPA) Purge Pump and Separator Assy (PPSA): Initiated
- Exploration Potable Water Dispenser (xPWD): Initiated



Exploration Potable Water Dispenser



WPA Catalytic Reactor



CapiSorb Visible System



Environmental Monitoring



MinION MK1C



BioMole Water Filtration Kit



Spacecraft Atmosphere Monitor TDU1

- Spacecraft Atmosphere Monitor (SAM) Technology Demonstration Unit 2: SpX-29
- BioMole Water Filtration Kit: Initiated
- MinION MK1C: Initiated



Fire Safety

Saffire-VI: Delivered



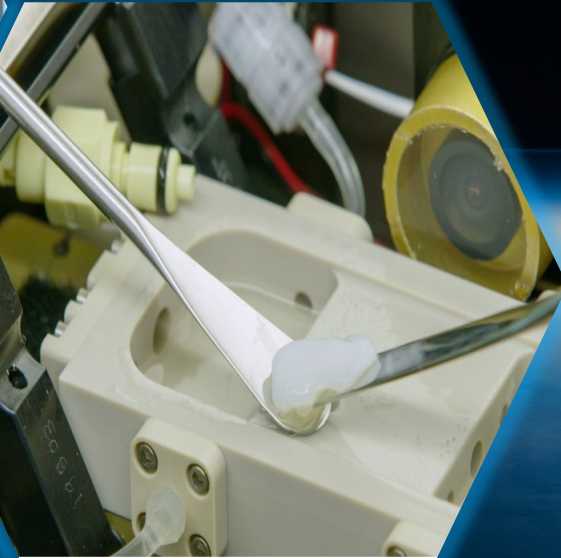
PMMA burning on Saffire-V

Human Meniscus 3D Printed in Space

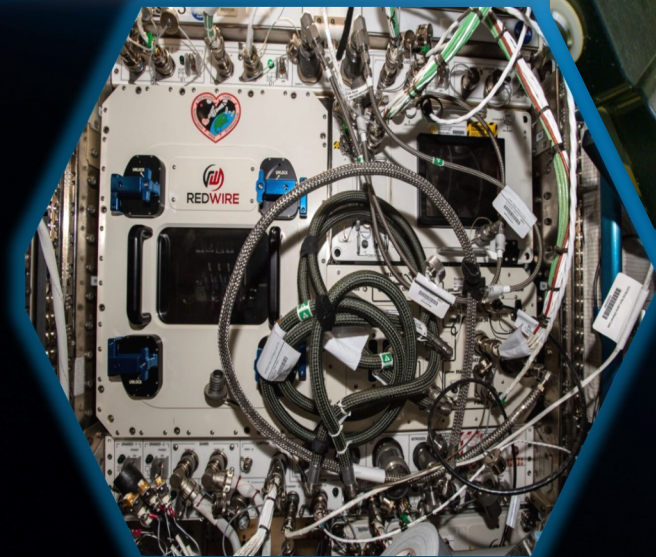
Redwire Space



Top Left: NASA astronaut Woody Hoburg works on the BFF Meniscus Investigation. Credit: NASA



*Right: A knee meniscus successfully bioprinted in space. Credit: Redwire Space
Bottom Left: BioFabrication Facility from Redwire Space. Credit: NASA*



OVERVIEW

The BFF-Meniscus-2 Investigation aims to explore how space bioprinting can help treat meniscal injuries, one of the most common orthopedic injuries affecting U.S. service military members.

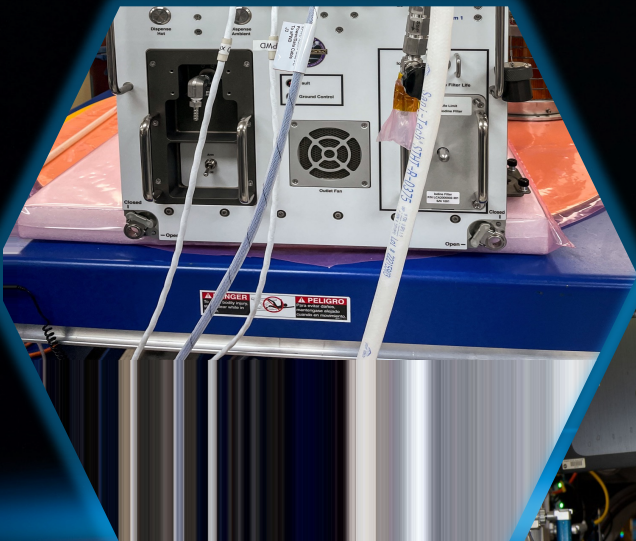
RESULTS

Researchers were able to successfully 3D print the first human meniscus (a piece of cartilage in the knee joint) in space, using Redwire Space's BioFabrication Facility.

IMPACT

Crew members who experience musculoskeletal injuries on future deep space missions may benefit from the capability to bioprint tissue such as knee cartilage to promote recovery.

New Water Dispenser Improves Water Sanitization on Station



Right: Jasmine Moghbeli collecting water samples for analysis during xPWD check out. Credit: NASA



Top left: xPWD during ground testing.
Bottom left: xPWD Iodine Filter.
Credit: NASA



OVERVIEW

The Exploration Potable Water Dispenser (xPWD) provides drinkable water at the proper temperature for both food and beverage rehydration, advancing the existing ISS Potable Water Dispenser by adding UV disinfection to eliminate a consumable filter and reducing the potential for microbial growth during periods of dormancy.

RESULTS

After initial successful demonstration, xPWD was cleared for operational use onboard the ISS.

IMPACT

An efficient and reliable potable water dispensation system is essential for long duration human spaceflight missions. Additionally, this new technology enables reduced logistics and mass needed for long duration exploration missions. This successful demonstration proves NASA is on track to develop the technology to prepare for deep space exploration missions.

The White House Cancer Moonshot Initiative



Right: The White House Cancer Moonshot initiative aims to advance research to prevent cancer deaths by 2047.



Top left and Bottom Left: NASA Astronauts Peggy Whitson and Serena Aunon-Chancellor working on cancer research aboard the Space Station. Credit: NASA



OVERVIEW

The Cancer Moonshot is a White House initiative to mobilize efforts which aim to achieve two goals: to prevent more than 4 million cancer deaths by 2047, and to improve the experience of people who are touched by cancer. The White House named the ISS a key player in this initiative.

RESULTS

Scientists use the Space Station's unique microgravity environment to perform research on cancer. For example, biotechnology MicroQuin has used microgravity to study the process that transforms normal cells into cancer cells. Sanford Stem Cell Institute sent cancer cells to space twice to study factors that drive the growth of cancer cells.

IMPACT

Cancer is still the second leading cause of death in America despite progress made in recent decades. Cancer research on the Space Station could help develop new treatments for the benefit of humanity.

International Space Station

Science Instruments

Commercial Facility
 Earth Science
 Space Science
 Technology Demonstration



External Logistics Carriers – ELC-1, ELC-2, ELC-3
 External Stowage Platforms – ESP-3
 Alpha Magnetic Spectrometer
 Columbus External Payload Facility
 Kibo External Payload Facility

ISS National Laboratory
 NASA
 European Space Agency
 Japanese Aerospace Exploration Agency

ISS Research Statistics



Working Data as of July 31, 2023

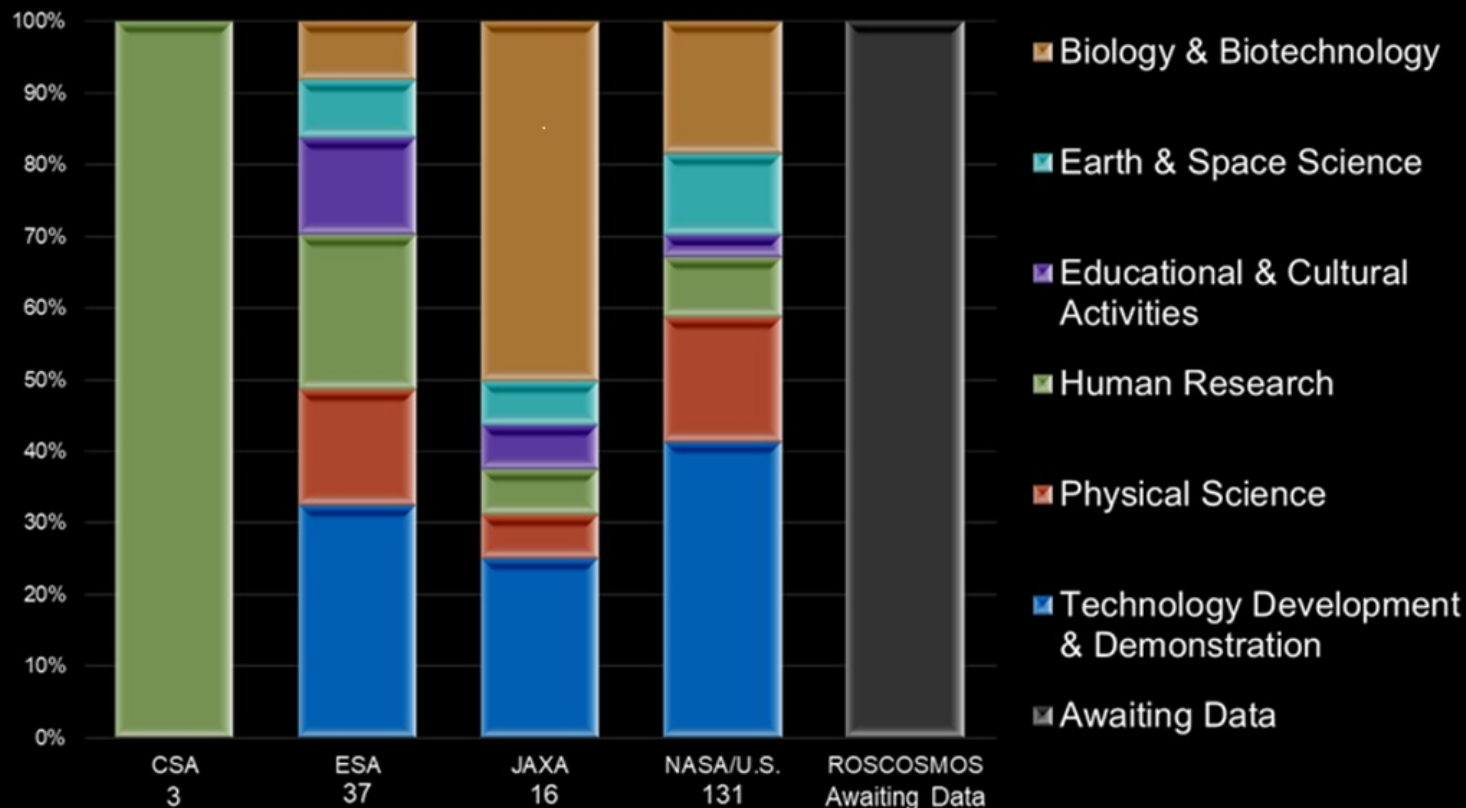
Current Investigations for 70: 189

- 131 NASA/U.S.-led investigations
- 58 International-led investigations
- 60 New Investigations
- 0 CSA
- 10 ESA
- 3 JAXA
- 47 NASA/US

MCB Approved Statistics Exp. 0-68

- 3724 Investigations
- 5308 Investigators Represented
- 116 Countries/Areas with ISS Research and Education Participation
- Over 3173 Scientific Results Publications (Dec 1998 – Jun 2023)

Expedition 70 Research and Technology Investigations



Estimated Number of Investigations Expedition 0-70: 3855

*Pending Post Increment Adjustments

Education on Station

GENES IN SPACE



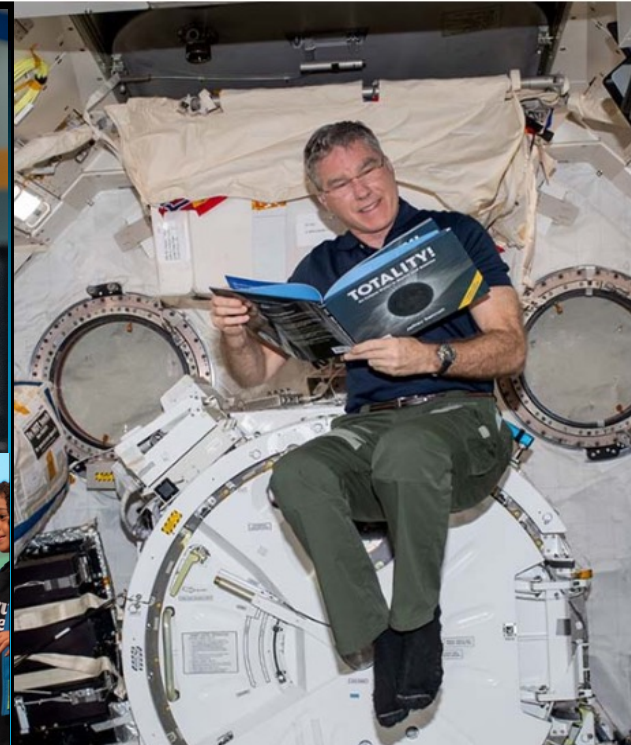
High School student Isabel Jaing wins 2023 Genes in Space competition for her study on how latent viruses react in space

GIRL SCOUT CONVENTION



ISS National Lab sponsored the Girl Scout Phenom Convention and partnered with NASA's Destination Station to reach 2,380 Girl Scouts and troop leaders.

STORY TIME FROM SPACE



NASA Astronaut Steve Bowen read "Totality!" by Jeff Bennett as part of Story Time from Space. He then performed a science demo to illustrate eclipses.

SPACE STATION AMBASSADOR PROGRAM



The Space Station Ambassador Program continues to expand with 81 new partners in Q4

Space Station Public Engagements

NASA launches new app to help stargazers spot the Space Station



DOWNLOAD THE ALL-NEW **SPOT THE STATION APP**



ISS National Lab Status (CASIS)



- **CASIS met or exceeded all target metrics in FY23**
- **Staff Changes and Updates**
 - Dorothy Rasco and Sol Glasner joined the ISSNL Board of Directors, Betsy Cantwell stepping off the board Dec 2023
 - CASIS is now fully staffed with no attrition the past year
- **Continuing to see more demand than resources available**
- **Successful ISS Research and Development Conference in Seattle, WA – 906 Registered, 2nd largest attendance ever**
- **Igniting Innovations Solicitation released in August, over 50 proposals received**
 - Collaboration with NASA's Biological and Physical Sciences (BPS) Division
 - Focus on cancer research in line with Cancer MoonshotSM and accelerating translation of stem cell and organoid based disease models and advanced technologies for biomanufacturing
- **National Laboratory in LEO**
 - ISS continuing to work on formal action from National Space Council to develop strategy for future National Lab in LEO
 - SOMD Briefed NSpC on status and results of the OTPS report in September 2023
 - OSTP hosted a Federal Workshop to explore opportunities and pivotal programs for collaborative LEO research in October 2023
 - Selected groups will continue to meet throughout the next year and the agencies will meet again in June 2024 to continue planning and preparing diverse research opportunities

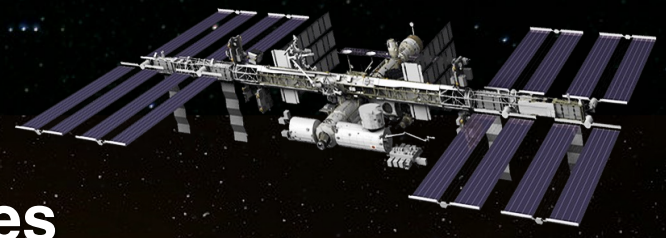
LEO Transition



LEO Goals

- Continue sustained human presence and U.S. leadership in LEO
- Transition to a regime where NASA is one of many customers in the LEO commercial human space flight enterprise
- Continue partnering with non-U.S. government space agencies on research objectives and other areas of common interest
- Commercially-owned and operated cargo and crew transportation, and eventually destinations that are safe, reliable, and cost-effective
- Meet US Government research and technology development requirements as they evolve
- Continue to support and expand the development of a Commercial LEO Economy
- Enable exploration beyond LEO
- Return benefits for humanity, solve Earth's challenges
- Inspire humankind, next generation of STEM learners and develop workforce

Transition Activities



Category

Activities

Status

NASA LEO Needs

- Utilization RFI Spring 2023
- Planning for transition of research from ISS to CLDs
- Payload interface standards

- Prioritizing NASA's needs/desired capabilities
- Updating ISS/LEO tech demo plan
- Results of BPS Decadal Survey

National Lab

- NASA/OTPS study on potential NL models & SOMD Strategy
- OSTP interagency working group on govt approach for sustained LEO R&D

- Strategy in work, socializing with stakeholders
- Federal LEO R&D workshop Oct 10-11, 2023

ISS End of Life Planning

- US Deorbit Vehicle Procurement
- Facility transition planning

- USDV RFP released Sept 2023, proposals coming months
- \$180M included in FY 2024 Domestic Emergency Supplemental Request

Whole of Govt/Regulatory

- NSpC chairing In-space Authorization & Supervision Policy (IASP) Sub-Interagency Space Policy Committee

- Ongoing committee meetings

International Partners

- ISS International Partner Transition Working Group
- Expanding discussions with international community
- Discussions Informing National Lab strategy

- Partners defining post-ISS LEO research and utilization plans and requirements
- Refining pathways for international cooperation

Challenges of Transition



NO GAP IN LEO



**TIMELINE
FLEXIBILITY**



**CONTINUITY
OF PAYLOAD
CAPABILITY**



**MARKET
MATURITY**

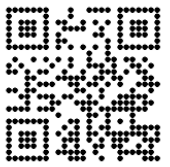


Resources

National Aeronautics and
Space Administration

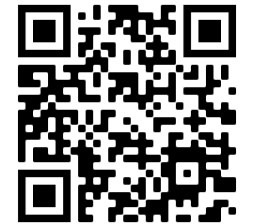


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